EXHIBIT G

Property-Level Benchmarking of Real Estate Development Investments Using the NCREIF Property Index

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The NCREIF Property Index (NPI) is widely used as a benchmark for property-level performance of institutional "core" real estate investments in the U.S. The term "core" here refers to fully operational (or "stabilized") properties that are both physically complete and largely leased up. The NPI is generally an appropriate benchmark for institutional (i.e., pension and endowment fund) investors to use for this type of real estate investment, because the vast majority of such properties held by such investors are included in the NPI. This allows the NPI to effectively represent the performance of the relevant investment "peer universe." In this regard it is useful that the NPI is a relatively "style-pure" index for the institutional core consisting of stabilized properties. The design and criteria governing the NPI generally prevent the index from including types of property investments different from the above-defined core, such as properties in development, redevelopment, or initial lease-up (absorption) phases of their life cycles.

In recent years many pension funds have begun investing in properties outside of the traditional core, notably including development projects. This raises the question of how to benchmark such investments. At the fund level, most such investments are found in specialized funds such as "opportunity" or "value-added" funds. It is relatively straightforward to compare the performance of any one such fund with a peer universe consisting of all (or nearly all) other similar-style funds. Such fund-level benchmarking is completely appropriate, in principle, and should generally be quite useful in practice if carefully applied. However, there is some interest in going beyond the fund level to an examination of the property-level investment performance of development projects. Such property-level analysis is particularly useful for *diagnostic* purposes (e.g., *"What happened?"* and *"Why?"*), as opposed to *evaluation* (e.g., *"How 'good' was Fund A's performance?"*). While much useful property-level analysis can be done without the use of a formal benchmark, some property-level analysis of development investments could probably benefit from the availability of a property-level benchmark appropriate for these non-core style investments.

This brings us to the question this article will address: Given the current state of data availability in the U.S. private real estate investment industry:

What are some practical guidelines and tools regarding how to benchmark development and lease-up phase investments at the property level?

In addressing this question it is important to note at the outset that the NPI cannot be used directly as an appropriate benchmark because development investments have a different level of risk than the core properties in the NPI. Nor would it make sense to combine development projects together with the core

The Importance of Style-Purity

Style-purity is important for indices to be useful as benchmarks, because it is not appropriate to compare the performance of one style of investment against that of another style for purposes of evaluating a manager who is specialized in (and hired for the purpose of) investing in one particular style. Of course, multi-style managers and portfolios can be benchmarked using composite indices constructed from an appropriate combination of style-pure indices. Thus, style-pure indices are also needed as building blocks for multi-style benchmarking. Comparative analysis and diagnostics regarding the differential performance of different types of investments is also facilitated by the availability of style-pure indices.

properties in some sort of "expanded NPI," because such an index would lack style-purity and thereby become ambiguous and inappropriate for benchmarking. Furthermore, NCREIF currently has relatively few non-core properties in its database.[1] Yet another problem is that development projects are usually not regularly marked-to-market, making it difficult to accurately derive periodic returns and time-weighted average returns for such assets. This makes it technically difficult, in principle, to incorporate such properties in the NPI, or to construct a separate quarterly periodic return index representing such properties. *What can be done?...*

Benchmarking development using the NPI: The basic idea...

When you do not have what you would ideally like to have (lots of property-level data on development and lease-up projects), you make do with what you do have. What we have is the NPI. This article shows how, with a little bit of "financial engineering," the NPI can be applied to develop a property-level benchmark for the development phase. This is possible because most such investments made by pension funds result in buildings that will (or could) form part of the institutional core once they are complete and stabilized. In other words, the values of the underlying assets (the stabilized completed buildings) that are being produced by these development investments should be very well tracked over time by the NPI (where the NPI is understood to include appropriate market-segment sub-indices of the aggregate NPI). This makes it possible in principle to use the NPI to produce *simulated performance indices.*[2]

In essence, from an investment perspective, development can be viewed as a levered long position in the future stabilized property to be built. This enables the returns to development projects to be simulated based on the appreciation returns to the NPI, together with some assumptions about the specific nature of these investment projects.

THE FUNDAMENTAL NATURE OF REAL ESTATE DEVELOPMENT INVESTMENT[3]

A forward purchase commitment...

To see how one might reasonably benchmark development projects using the NPI, we need to first step back and consider the fundamental nature of development investment from a financial economic perspective. For the equity investor in a development project, such an investment can be viewed as a commitment to make a forward purchase of the completed property at the time of completion of construction. Two payments are typically required in this forward purchase commitment. The first is an up-front payment at the time the project begins. This payment reflects the opportunity cost of the land as well as any fees that must be paid prior to construction.[4] The second payment in the forward purchase commitment then pays for the construction costs, usually in the form of the balance due on a construction loan, and is made at the time of project completion, whereupon the development investor obtains the completed property asset.[5] This completed property is typically an asset much like those represented by the NPI. Thus, a development project is a forward purchase commitment with a maturity equal to the duration of the construction project, requiring two payments, one up-front and one at the time of completion of construction.[6]

A levered investment...

It is important to note that, not only is the development project a forward investment commitment in the future core property being built, it is typically a *levered* investment in that property. The investment of the up-front opportunity cost of the land is combined with the forward commitment of one or more relatively fixed future payments for construction. The resulting *operational leverage* is inherent in the nature of the development project, and additional financial leverage is usually added by the use of a construction loan. The construction loan replaces several construction payments due the contractor during the course of the project with a single financially equiv-

alent payment at the completion of the project. In the absence of some sort of subsidy in the loan, this does not change either the value of the construction costs measured either on a present value or terminal value basis, nor does the use of such construction financing change the NPV of the development project.[7] However, pushing the construction payment to later in time magnifies the leverage in the project IRR.[8]

Fundamentally, leverage in development investment derives from the fact that the construction costs are relatively fixed at the outset of the project, and do not vary in a manner that is highly correlated with the variations over time in the value of the completed property. The up-front development equity investment only buys a *net* asset, the difference between the future built property value and the construction costs. This may be viewed as the difference between the values of an asset and a liability, or equivalently as a combination of long and short positions in two future payoffs. The underlying asset (in which the long position is held) is the stabilized property free and clear (like the NPI core properties), a type of asset whose value changes over time with the volatility typical of core properties. The liability is the construction cost exclusive of land and any other up-front payment. (Equivalently, you can think of this liability as a short position in a payoff whose value equals the cost of construction exclusive of the up-front payments.) This liability is a type of cash outflow obligation that is relatively short-term in duration (due on completion of the construction) and fixed in amount, not subject to the same type of volatility as the value of the underlying core property being built. As demonstrated in the Appendix at the end of this paper, the result is leverage for the equity investor in the development project.

A simple numerical example...

To see more concretely how development is essentially and effectively modeled as a forward levered long position in the stabilized (core) property to be built, consider the following simplified numerical example. Suppose we are going to build an apartment building typical of the type that is in the NPI. Suppose that such properties in the NPI are currently worth $10,000,000. Construction will take one year, after which time the property will be fully operational and we will owe the construction contractor (or the construction lender) $7,680,000, which will cover all construction costs (including interest, but excluding land cost). Our up-front equity investment today in this development project is $2,000,000, a sum that covers land acquisition and other up-front fees.[9] Assuming that NPI-type apartment buildings like the one we are building are likely to be worth the same value next year as today, our going-in expected return on our development equity investment is 16%:

$$16\% = \frac{E[End\,Val] - Beg\,Val}{Beg\,Val} = \frac{(\$10,000,000 - \$7,680,000) - \$2,000,000}{\$2,000,000}$$

The "$E[\,]$" notation indicates that the ending value is not an amount known with certainty at the time the project begins, but rather is an *expectation.*

Now suppose that between now and next year such apartment property values take an unexpected plunge of 10%, to $9,000,000. For an unlevered investor in a previously operational such property, the appreciation return hit is just this 10% loss. But to our development investment our loss is magnified to 50% below the previous +16% expectation. We obtain a return of −34%, which is 50% below +16%:

$$-34\% = \frac{(\$9,000,000 - \$7,680,000) - \$2,000,000}{\$2,000,000} = \frac{-\$680,000}{\$2,000,000}$$

Similarly, our upside is magnified compared to the core property investor if there is an unexpected upswing in apartment property values. For example, a 10% increase in apartment property value will result in a 50% increase in our initial development investment over and above our previous 16% expectation:

$$66\% = \frac{(\$11,000,000 - \$7,680,000) - \$2,000,000}{\$2,000,000} = \frac{\$1,320,000}{\$2,000,000}$$

It is important to take note of the reason why the effect of the underlying core property value change was magnified in the development investment return in this example. The return-change magnification occurred because the construction cost ($7,680,000) did not change in direct proportion with the change in the underlying core property value. (See the Appendix for a formal derivation of this point.) In fact, in this simple example, the construction cost did not change at all.

It is also important to note that, while the change in core property value was magnified in the development project investment return, this return did change in the *same direction* as that of the type of core property being built.

The relationship of development returns to NPI returns...

In general, it is to be expected that realized returns to development projects should be very highly correlated over time with the realized appreciation returns to the underlying core types of properties that are being built in the development projects. Therefore, property level returns to development investments should be highly correlated with appreciation returns in the NPI. Of course, because of the leverage described previously, it is also to be expected that the volatility of development project returns should be much greater than the volatility of NPI returns. When the NPI does well, development projects should generally do *very* well, better than the NPI. When the NPI does poorly, development projects should do even worse, providing returns below the NPI.

Thus, development investment is more risky than core (NPI) investment.[10] This greater risk requires a commensurately greater risk premium in development investment expected returns going forward (ex ante, i.e., in the "going-in IRR" expected from development investment). For this reason, we would expect development projects to earn higher returns than the NPI *on average over the long run*.

DEVELOPMENT INVESTMENT RETURN EXPECTATIONS RELATIVE TO THE NPI

The nature of development project equity investment as described in the preceding section has implications for the magnitude of total return that it makes sense to expect on such investment, going forward, and on average over the long run or across many such investments. In particular, because development investments are, essentially, like levered investments in the types of core properties that are being constructed, it is reasonable to quantify a sort of expected *yield spread* between development investment and core investment as represented by the NPI.

The traditional weighted average cost of capital (WACC) formula can be used as a reasonably accurate approximation to quantify the normative relationship that should exist between development investment return expectations and NPI core investment return expectations.[11] The WACC formula is given below:

$$r_P = (1 - E/V)r_D + (E/V)r_E \tag{1a}$$

In the present context, this formula can be interpreted as follows:

r_P = Return on underlying core (stabilized) property of the type being built;

r_D = Return (to the lender) on the construction loan;

r_E = Return on levered equity (up-front development investment);

V = Value of completed property;

E = Up-front equity investment (land and fees).

Although the above formulation is familiar and intuitive, it is equivalent to write Formula (1a) in the following form, which will be more directly useful for our present purposes:

$$r_E = r_D + (r_P - r_D)LR \tag{1b}$$

where LR is the *leverage ratio*, defined as the underlying gross asset value divided by the equity investment: $LR = V/E$. Thus, the return on the equity equals the return on the debt plus the spread between the underlying property asset and debt returns, magnified by the leverage ratio.[12]

Of course, any total return can be broken out into a risk-free interest rate component that compensates the investor for the time value of money, plus a risk premium component that compensates the investor for the risk in the investment (at least on an ex ante basis). Thus, using the expectation operator, $E[]$, to represent ex ante expectations, and re-labeling the equity return (r_E) in the above formula as "r_c" to remind us that it is the return to investment in the construction (or development) phase of the property's life cycle, we have:

$$E[r_c] = r_f + E[RP_c] \tag{2}$$

where r_f is the risk-free interest rate (usually proxied by the yield on U.S. Treasury bills), and $E[RP_c]$ is the expected return risk premium required for investment in development projects.

As the WACC formula can be applied to any additive component of the total return, from (1b) we have:

$$E[RP_c] = E[RP_D] + (E[RP_P] - E[RP_D])LR \qquad (3)$$

where RP_D and RP_P are, respectively, the expected return risk premia in the debt (construction costs) and in the type of stabilized (core) property being developed.

As an example, suppose (plausibly) that the ex ante risk premium in core property investments is 300 basis points, and the risk premium in the construction loan's expected return is 100 basis points.[13] Suppose further that a given development project is effectively levered to a leverage ratio of five.[14] Then Formula (3) tells us that the ex ante risk premium in the up-front equity investment in the development project should be 1,100 basis points, computed as follows.

$$\begin{aligned} E[RP_c] &= 100bp + (300bp - 100bp) * 5 \\ &= 100bp + (200bp) * 5 \\ &= 100bp + 1000bp = 1100bp \end{aligned}$$

If we suppose further that T-bills are currently yielding 5%, then this implies that the expected return on the development project investment, $E[r_c]$, should be 16% per annum, as:

$$E[r_c] = r_f + E[RP_c] = 5\% + 11\% = 16\%$$

Thus, 16% would be a reasonable going-in IRR to expect from the up-front equity investment in such development projects.[15]

In this example the spread in expected return of development investment over core (NPI) investment is 800 basis points. This reflects the difference between the 1,100 bp risk premium on the development project minus the 300 bp risk premium on core property of the type being built. Note that the implied total return expectation in the NPI in this example is 8% (the 5% risk-free rate plus the 3% risk premium), which is 8% less than the development project return expectation of 16%.

In general, Formula (3) is a useful tool to estimate the approximate reasonable or normative relationship between the total returns to development projects and to core property investments of the same general type of property being built in the development projects. The spread in the total return expectation is attributable entirely to the spread in the ex ante risk premia, of course, reflecting the fact that the only reason why the expected returns on the two types of investments should differ is because of the difference in risk. Ex ante (that is, looking forward in time, as with going-in IRRs) risk premia like those represented in Formula (3) reflect the amount of risk in the investment as perceived by the capital market, and the capital market's price of that risk (where the real estate asset market is viewed as a branch of the capital market).

Spreads over NPI...

Based on Formula (3), the ex ante spread between development and NPI core investment is given directly as:

$$Spread = (E[RP_P] - E[RP_D])(LR - 1) \qquad (4)$$

For example, using the previous numbers, LR was 5 and the spread between $E[RP_P]$ for the NPI and $E[RP_D]$ for construction costs was 200 bps, so the spread of the development investment expected return over that of the NPI was: 200*(5 − 1) = 200*4 = 800 bps.

Use of ex ante spreads...

Ex ante spreads of this nature, between development and core investments, are useful for several purposes, for example:

- ***Pricing development projects.*** By adding the development spread to the typical going-in IRR applied to evaluate stabilized properties of the type being built, it is possible to evaluate development projects based on the cash flows anticipated in the development phase alone (ending with the projected value of the completed stabilized project). In effect, the development spread plus the expected return to core investments equals the opportunity cost of capital (OCC) appropriate for the up-front equity investment in the development phase cash flows (including the land investment). This OCC can be used as the discount rate to determine the present value of the equity investment, which can then be compared to the up-front investment cost (including land opportunity cost) to determine the NPV of the development investment.[16]
- ***Expectations about development investment performance.*** The ex ante return to development projects is useful at a macro (or aggregate) level to gain insight into what sort of return performance is reasonable to expect in the future from style-pure property-level investment in development projects, that is,

from investment purely in the development phase of the property life cycle. Such total return expectations can be useful for strategic and tactical portfolio allocation and management.

- *Quantify relative risk across types of investments.* The amount of risk in different types of investments (as perceived and priced by the capital market) is proportional to the ex ante risk premia offered by each type of investment (assuming investment at fair market value). Thus, quantifying ex ante returns is a way to quantify the relative amount of risk in each type of investment, an important consideration in portfolio strategy. For example, in our previous apartment project, the development investment apparently had 1,100/300 = 3.67 times the risk of the underlying stabilized property investment, as the capital market perceives and values such risk.

Ex ante spreads are not benchmarks...

Although ex ante spreads are useful, it is important to understand the difference between ex ante spreads and benchmarks. The ex ante spreads described above are forward-looking, normative expectations. Benchmarks are backward-looking, empirical indications of historical performance results within a relevant peer universe. Thus, for example, it would not be appropriate to simply add the ex ante yield spread described above (e.g., the 800 bp computed previously) to the ex post NPI return during a given historical period to arrive at an appropriate benchmark for development projects during that period.

A useful way to understand the difference between ex ante spreads and benchmarks is by reference to the bond market. The ex ante spreads we have been describing are similar to the spreads observed in the yields of corporate and government bonds of similar maturity. Such bond market yield spreads are forward-looking. They are used to price bonds (analogous to estimating the NPV of a new development project), and also to help form expectations about the returns current investors will receive if they hold the bonds to maturity.[17] The corporate-Treasury yield spread reflects the degree of default risk in the corporate bonds as perceived by the bond market. Such spreads are always positive, because default risk is always present in corporate bonds and not in government bonds. But such bond yield spreads are not used to benchmark corporate bond portfolios or investment managers that specialize in corporate bonds.

Benchmarking of corporate bond investment portfolios is done using indices of ex post (that is, *historical*) periodic total returns to corporate bonds ("holding period returns," or HPRs). While the yield spread between corporates and Treasuries is always positive, the ex post return differential may be either positive or negative in any given period of time. During periods of economic distress, ex post corporate bond returns naturally fall below the ex post returns on Treasury bonds, especially if the corporate bond returns are adjusted to reflect credit losses. During such periods yield spreads typically widen, corporate credit-ratings drop, and some defaults occur, all of which causes corporate bond portfolios to lose capital value relative to similar-duration Treasury bonds. Benchmarking corporate bond investment managers and portfolios for purposes of investment performance evaluation is done by comparing the realized ex post return of the given manager's bond portfolio to the realized ex post return obtained by other managers of similar corporate bond portfolios (or by an HPR index of all such corporate bonds).

Similarly, the ex ante return spread between development and core property is always positive, because development is inherently more risky than core investment (due to the leverage in the development phase), and such additional risk requires additional expected return. But this ex ante spread does not depict the difference between development and NPI ex post returns that we would expect in a given historical period relevant for benchmarking. As noted previously, it is to be expected that development investments will generally tend to underperform the NPI when real estate market values decline suddenly or unexpectedly. Similarly, development would normally be expected to exceed its long-run average spread over the NPI during "boom" periods, when property values are rising sharply.

BENCHMARKING DEVELOPMENT INVESTMENTS USING THE NPI

This brings us back to the main subject of this article: how to use the NPI for property-level benchmarking of development projects. Given that benchmarking is an ongoing ex post comparison exercise, what is proposed in this section is a way to use the NPI to produce a simulated historical index of how well it would have been reasonable to expect that typical development projects should have performed during any given historical period, assuming that they were constructing buildings similar to those in the NPI. Before outlining the details of such a benchmark index, however, we need to step back and review

some basic principles and guidelines relevant for benchmarking development projects in general.

Some basic considerations in benchmarking development projects...[18]

The purpose of benchmarking is generally to assist with the evaluation of the performance of investment agents or the diagnosis of the performance of investment assets or portfolios. In the case of property-level benchmarking of private real estate investments, the role of this exercise is often more diagnostic than evaluative. In any case, the benchmarking exercise is essentially a comparison between two ex post total returns: that achieved by the subject property or portfolio, and that achieved by the benchmark index during the same historical period. In the case of traditional core investment, it is usually considered to be most appropriate to use the *time-weighted rate of return* (TWRR) in such benchmarking. This is because TWRRs are neutral with respect to the timing of capital flow to and from the investment manager. This is an appropriate trait for a benchmark index if the agent being evaluated has little control over that timing. There is also a strong rationale for TWRR-based evaluation of real estate investments because the mainstream stock and bond investments that dominate the core of most mixed-asset institutional portfolios are usually evaluated using TWRRs.

The main alternative to the TWRR in investment evaluation and benchmarking is the internal rate of return (IRR). The IRR is an inherently multi-period, dollar-weighted (or "money-weighted") return measure that, unlike the TWRR, is sensitive to the effect of capital flow timing. Another important difference between the IRR and the TWRR is that computation of the IRR does not require knowledge of the capital asset value at intermediate points in time between the initial investment and the terminal point in time as of when the investment is being evaluated.

Considering the above, there are two strong arguments in favor of benchmarking development projects using the IRR rather than the TWRR:

- Most development projects are not regularly appraised and marked-to-market during the construction phase of the project. Instead, construction projects are carried on the investor's books at historical cost until the projects are complete and/or the completed buildings are sold. It often makes little sense to try to appraise and mark-to-market buildings that are under construction or rehabilitation, as it is difficult to obtain accurate estimates of value for such assets.
- Development projects often require, and give, greater discretion over capital flow timing to the project manager than is typically the case for core property investments. Indeed, most of the cash flows into and out of a development project are capital flows, and the strategies and tactics of construction technique, phasing, financing, and lease-up or sell-off of completed assets can greatly affect the timing of these flows.

These features make real estate development projects more comparable to such private investment asset classes as venture capital, for which IRR-based benchmarking is the standard procedure, than to core portfolio investment such as stocks, bonds, and stabilized real estate.

Use of IRR-based benchmarking for development projects...

Private investments that are not regularly marked-to-market using widely-accepted appraisal techniques such as those of core real estate assets are usually evaluated using IRR-based benchmarks rather than TWRR-based benchmarks. Although AIMR recognizes the appropriateness of the TWRR in most institutional investment situations, it recommends that practitioners measuring the performance of individual private investments employ the IRR from the inception of those investments.

IRR-based benchmarking uses the annualized IRR since inception of the subject project or portfolio of projects being evaluated, known as the *since-inception IRR*. This requires the use of inception-date cohorts in the evaluation benchmark. It is not valid to compare the since-inception IRR of a subject project with the since-inception IRR of other projects that began at different times from the subject project. Performance evaluation comparisons should always be made over identical historical periods. For example, a development project that began in the first quarter of 2000 should be benchmarked against the average since-inception IRR of other (appropriately comparable) projects that also began in the first quarter of 2000.

In computing an IRR-based benchmark index, there are a variety of ways to calculate the average IRR across the peer universe cohort of projects represented by such an index. These methods include: equal-weighted average IRR, value-weighed average IRR, median IRR, and the

pooled IRR. The most widely employed method in the venture capital industry is the pooled IRR. In this method the net cash flows from all the projects in the cohort are pooled within each time period, as if they were all one giant project, and the IRR of those pooled cash flows is then determined. If the benchmark index were viewed as a statistical sample and each project in it were considered to be an equally-representative example of the performance of the underlying population, then it might be argued that an equal-weighted average of the individual project IRRs across all the projects in the index would be a better way to construct the benchmark. However, evaluation benchmark indices in the private investment industry are typically viewed not as statistical samples, but as peer universe populations. From this perspective, the pooling method makes considerable sense. It is also less susceptible than the equal-weighted average to the influence of a few outliers.[19]

In IRR-based benchmarking, it is necessary to determine or estimate a terminal value of the remaining assets in the project at the time when the since-inception IRR is being calculated. In the case of property-level real estate development benchmarking, the most logical time to perform benchmarking is upon completion of the development phase of the project, at which time the terminal value is normally just the value of the completed stabilized property. If this property is not sold at that time, then its value would normally be appraised by standard appraisal techniques. Then, the annualized since-inception IRR of the project can be calculated using the project's actual net cash inflows and outflows from/to its equity investors within each historical period and assuming that the completed property is (or could be) sold in the terminal period of the development project at its estimated market value as of that time. It is important to recognize that the estimated value of the completed property can greatly affect the project's since-inception IRR, because of the degree of leverage usually present in development projects. So it is particularly important to obtain accurate estimates of value.

Constructing a simulated IRR-cohort development project benchmark index based on the NPI...

NCREIF does not possess a sufficiently large and rich historical database of development projects to enable direct production of a benchmark index based on the pooled IRRs of inception-date cohorts of development projects actually in the database. However, NCREIF can use the stabilized properties in its database to produce a *simulated* development index. In effect, we can construct an index *as if* the properties in the NPI were constructed as development projects. This type of simulated index can be constructed either at the aggregate level based on the published NPI, or it can be constructed at the disaggregate level using individual property-level data.[20]

Construction of a simulated development benchmark index could proceed as follows. In a given calendar quarter t, construction projects are begun that will produce completed buildings T quarters later (at $t+T$). The projects are to produce stabilized properties whose values equal the average value of similar properties in the NPI. The current average value of such stabilized properties in the NPI is labeled V_s as of any quarter s. Thus, as of the time the projects begin, such stabilized properties are worth V_t, and upon completion T quarters later such properties are worth V_{t+T}. V_{t+T} is thus the simulated actual completed property value outcome from the cohort of development projects that begins in quarter t and takes T quarters to complete.

As of time t developers are able to observe the current values of the types of buildings they are to build, V_t. Based on these observations and some expected inflation or appreciation rate, they forecast an expected value of the completed property T quarters later. We will label this expected future value F_{t+T}.

$$F_{t+T} = \left(1 + E_t[g_P]\right)^T V_t \tag{5}$$

where $E_t[g_P]$ is the developers' expected quarterly appreciation rate in stabilized property values over the next T quarters going forward from quarter t.

Also at time t, developers put together a construction budget (exclusive of land cost) that envisions the payment of a future amount D_{t+T} upon completion of the project at time $t+T$. This is, in effect, a projection of the balance due on a construction loan that covers all construction costs, exclusive of land cost.

Now let us define an expected *terminal leverage ratio*, *TLR*, as follows:

$$TLR = \frac{F_{t+T}}{E_{t+T}} = \frac{F_{t+T}}{F_{t+T} - D_{t+T}}$$

where: $E_{t+T} = F_{t+T} - D_{t+T}$, the development investor's expected net payoff at time $t+T$. The *TLR* therefore equals the inverse of the expected equity value fraction of the completed property value at time $t+T$. This is of

course equivalent to the inverse of one minus the anticipated loan-to-value ratio when the construction loan comes due at the end of the construction phase (LTV_{t+T}). Because anticipated construction loan LTVs are a well understood and ubiquitously quantified parameter in typical development project financing, the TLR is easily quantified by thinking in terms of the anticipated LTV, as follows.

$$TLR = \frac{1}{1 - D_{t+T}/V_{t+T}} = \frac{1}{1 - LTV_{t+T}}$$

As noted, this terminal leverage ratio is a bit less than the expected effective leverage ratio in the project IRR at inception.[21]

Thus, D_{t+T} is given as:

$$D_{t+T} = LTV_{t+T}V_{t+T} = (1 - 1/TLR)V_{t+T} = (1 - 1/TLR)(1 + E_t[g_P])^T V_t \qquad (6)$$

The equity investment in the development project at time t is the amount, E_t, which provides the required going-in IRR expectation of $E_t[r_c]$ as of time t. Thus,

$$E_t = \frac{E_{t+T}}{(1 + E_t[r_c])^T} = \frac{V_{t+T} - D_{t+T}}{(1 + E_t[r_c])^T} = \frac{(1/TLR)(1 + E_t[g_P])^T V_t}{(1 + E_t[r_c])^T} \qquad (7)$$

Note that the development phase equity investment at time t must be in an amount no greater than E_t as defined in (7), or else equity investors would not agree to the investment as it would not provide sufficient expected return. On the other hand, it is generally unlikely that the project can be obtained for a price less than E_t, because that would provide a "super-normal" expected return to the development equity investor, which would normally imply that some other party is "making a mistake," doing a deal that provides them with a "sub-normal" return on a risk-adjusted basis.[22]

From (7) it is obvious that four values must be specified to estimate E_t: the quarter t completed property value (V_t); the developers' expected appreciation rate in such property over the next T quarters ($E_t[g_P]$); the project's anticipated terminal leverage ratio (TLR); and the time t going-in IRR required on the development's up-front equity investment ($E_t[r_c]$). Each of these values could be specified in the simulated benchmark index in various ways. We propose the following:

- V_t will be simulated by the actual historical NPI appreciation value level index (accumulation of the appreciation returns), only without capital expenditures taken out.[23]
- $E_t[g_P]$ will be simulated as the average of the three previous years' CPI inflation rate: $(CPI_t / CPI_{t-12})^{1/12} - 1$.[24]
- $E_t[r_c]$ will be simulated using the WACC formula as in Formulas (2) and (3), with r_f proxied by the T-bill yield as of quarter t. Thus:

$$E_t[r_c] = r_{f,t} + (E_t[RP_D] + (E_t[RP_P] - E_t[RP_D])LR) \qquad (8)$$

In applying Formula (8), various assumptions could be made about the expected risk premium parameter values. For pre-leased development projects we will make the assumptions described previously: $E_t[RP_P]$ = 300 bp, and $E_t[RP_D]$ = 100 bp. For speculative development projects we will assume an additional 200 bp ex ante risk premium in the completed (but empty) property, that is, we will assume $E_t[RP_P]$ = 500 bp for speculative developments.[25] LR will be assumed to be slightly larger than TLR for the reason noted previously.[26]

- TLR will be exogenously specified by the user of the benchmark index, to correspond approximately to the degree of leverage in the project being benchmarked. (Recall that the TLR equals the inverse of one minus the anticipated construction loan's LTV ratio when the loan comes due at project completion.) In practice, we could produce a range of different development benchmark indices, each corresponding to a different TLR value, and users could interpolate between these for intermediate TLR values.[27]

Once E_t is quantified, we compute the ex post IRR earned by the simulated inception-date cohort of development projects that began in quarter t and ended in quarter $t+T$. Under the assumption that the construction costs and debt remain fixed at their anticipated level of D_{t+T}, we have:

EXHIBIT 1A

Simulated Inception-Date Cohort IRRs for Pre-Leased Development (E[RPP]=300 bp) with T = 1 Year and TLR = 5, 3, and 1

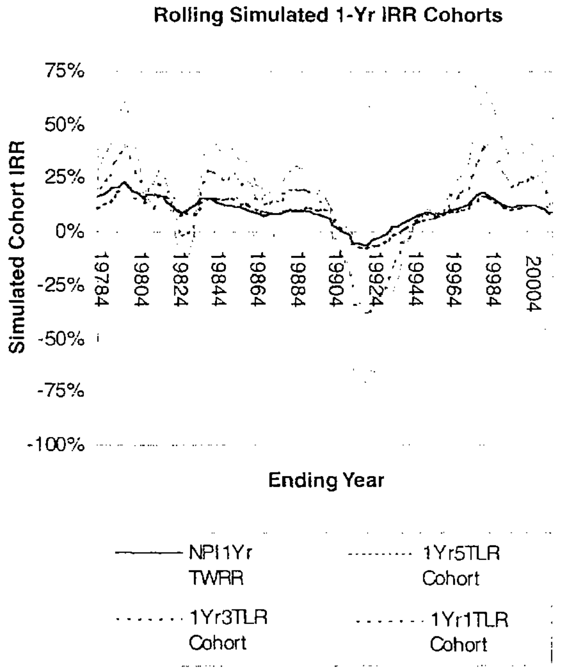
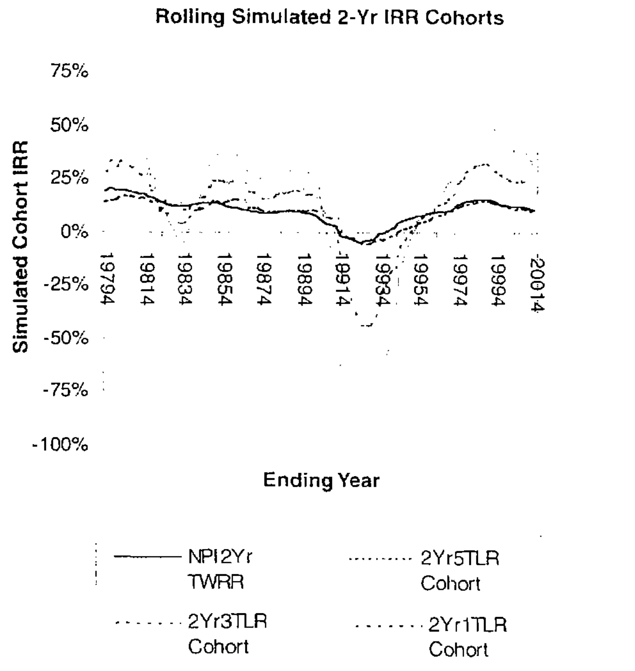


EXHIBIT 1B

Simulated Inception-Date Cohort IRRs for Pre-Leased Development (E[RPP]=300 bp) with T = 2 Years and TLR = 5, 3, and 1



$$E_t = \frac{V_{t+T} - D_{t+T}}{\left(1 + IRR_{t,T}\right)^T}$$

Thus:

$$IRR_{t,T} = \left(\frac{V_{t+T} - D_{t+T}}{E_t}\right)^{(1/T)} - 1 \qquad (9)$$

where $IRR_{t,T}$ is the simulated ex post IRR earned by the inception-date cohort that begins in quarter t and completes T quarters later, and E_t, D_{t+T}, and V_{t+T} are derived from Equations (6)-(8) as noted above.[28] Clearly, in this simulation, the realized ex post $IRR_{t,T}$ for each cohort of projects differs from $E_t[r_t]$, the ex ante expected return for that cohort, because, and only because, the actual realized property value, V_{t+T}, differs from F_{t+T}, the ex ante forecast of the completed property value as of time t defined in equation (5).

To implement the above-described system of simulated development project benchmark indices based on the NPI, several specific benchmark indices could be produced and published.[29] Separate series of indices could be produced, for example, for pre-leased and for speculative projects (for example, as we suggest with $E_t[RP_p]$ equal to 300 and 500 bp, respectively), for different degrees of leverage (e.g., for TLR values ranging from one to five), and for various values of project duration (T ranging, for example, from one to three years). Each index would show cohort IRRs for all historical inception quarters t up through T quarters back from the latest issue of the NPI.

Example simulated development project IRR-cohort benchmark indices...

Exhibits 1 and 2 show historical simulated development project IRR-cohort benchmark indices produced from the published aggregate NPI. Exhibit 1 is based on the 300 basis-point property risk premium assumption and therefore applies to pre-leased development projects. Exhibit 2 is based on the 500 basis-point property risk premium assumption and therefore applies to speculative development projects. Exhibits 1a and 2a apply to one-year projects, while Exhibits 1b and 2b apply to two-year projects. Each chart shows benchmarks for three differ-

EXHIBIT 2A

Simulated Inception-Date Cohort IRRs for Speculative Development (E[RPP]=500 bp) with T = 1 Year and TLR = 5, 3, and 1

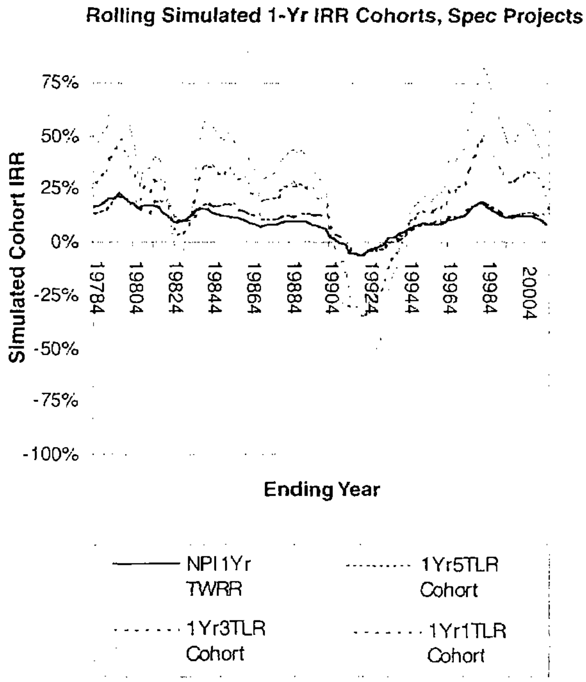
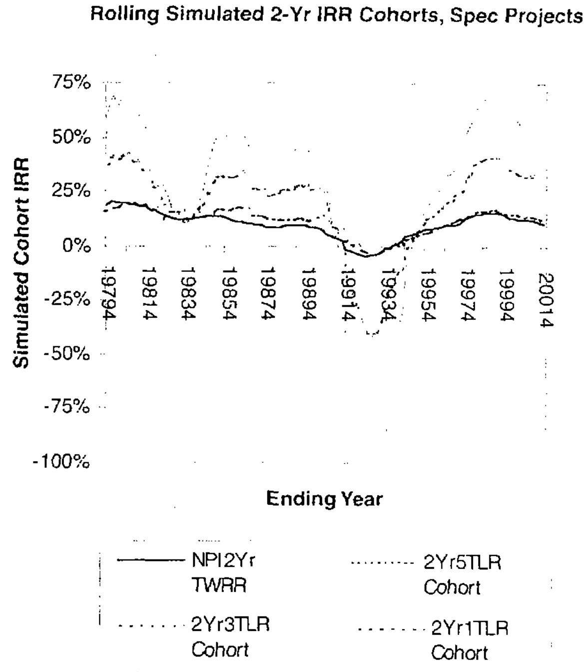


EXHIBIT 2B

Simulated Inception-Date Cohort IRRs for Speculative Development (E[RPP]=500 bp) with T = 2 Years and TLR = 5, 3, and 1



ent degrees of project leverage ($TLR = 1, 3$, and 5), corresponding to different degrees of operational and financial leverage. The charts also depict the rolling NPI TWRR corresponding to the same historical period as the development project benchmark indices.[30]

Several features of these example simulated development project cohort IRRs are noteworthy. First, they present the broad type of results we would expect: returns highly correlated with the NPI, but magnified (in both directions), the more so the greater the project leverage. When the NPI did well, the development project benchmark did even better, and vice versa. Secondly, it is interesting and instructive to note that, during the period of history covered by the NCREIF Index, development seems to have been subject to more extreme downside outcomes than upside outcomes. At least when projects are highly levered, there seems to be a potentially asymmetrical outcome probability distribution, skewed with a particularly long (or "fat") tail on the downside of the return distribution. This is evident during the property market crash of the early 1990s when some benchmark cohorts exhibited a negative 100% IRR, that is, a total loss for the initial equity investors. It should also be noted that, the way we have constructed the benchmark index, the results for the speculative index will tend to be superior to the results for the pre-leased index, because we have included the increased ex ante return requirement of speculative projects (500 versus 300 bp ex ante risk premium on the underlying built property), but we have not attempted to model the greater volatility or range of completed property value outcomes that can result from speculative development.[31]

It must be kept in mind that the simulated benchmark index is myopic. The index we have constructed here is not meant to represent what developers ideally *should* have done, but rather what *would* have happened had they acted according to the assumptions of the simulation model, assumptions which are clearly myopic (e.g., in forecasting future property appreciation using the trailing three-year inflation rate). Ideally (and hopefully), in the real world developers would be more foresighted, and they wouldn't begin any projects prior to a market crash such as occurred in the early 1990s. Alas, in reality, we know that one cause of such market downturns is often

that many development projects are indeed begun prior to the fall in market values.

With this in mind, it is important to reiterate that the simulated development benchmark index is meant to be a style-pure index. Such indices are useful for benchmarking because benchmarking is essentially a *cross-sectional* exercise, comparing the performance of assets of a *common style, over the same historical period*. In the present context, we might say that ideally there would have been no development projects to benchmark in 1992. But the point of this exercise is that, if there were any, an appropriate style benchmark would be one composed only of other development projects having the same inception date. The question a good development benchmark would allow us to address is not how well a given development project did in 1992 *absolutely*, but how well did it do *compared* to other development projects *at that time*. The simulated benchmark index is an attempt to use the NPI to estimate how well development projects in general would typically have been expected to perform over given historical time frames.

CONCLUSIONS AND CAVEATS

This article has discussed the property-level benchmarking of real estate development projects. We have shown how the NCREIF Property Index could be used to develop simulated benchmark indices for such projects. Such simulated indices quantify the historical ex post IRRs that would have been obtained by inception-date cohorts of stylized development projects characterized by a simple standard structure and ex ante expectational behavior. We have quantified examples of such simulated development project benchmark indices based on plausible behavioral and expectational assumptions, assumptions that could be easily modified by users who wish to make alternative assumptions. The simulated indices appear to be broadly reasonable as style-pure development project benchmarks.

It is important to note that there is a general trade-off in the investment business that is very applicable to the problem of benchmarking real estate development projects. The trade-off is between what we might call "benchmarkability" versus "uniqueness." The more unique are the investment assets being examined, the more cross-sectional variation that exists among them, the more difficult it is to construct benchmarks that can be rigorously used for performance evaluation purposes. This is because *tracking error* and random *noise* will inevitably loom large in the differential performance between the benchmark and the subject investments being evaluated. The easiest types of investments to benchmark are classical bond portfolios, because bonds are the most homogeneous and "commoditized" of investment assets. Real estate development projects are at the other end of the spectrum. Such investments exhibit greater uniqueness and variation even than stabilized core property assets.

Nevertheless, there are important arguments in defense of development project investments and attempts to benchmark them. With uniqueness comes the possibility of earning superior returns. Precisely because unique assets are difficult to evaluate, conservative investors shy away from investing in them, which can present opportunities to less timid investors. While problems of benchmarking real estate development projects make it more difficult to evaluate the performance of investment managers specializing in such projects, this very difficulty may make it easier for the assets these managers are investing in to provide higher returns, if the benchmarking difficulties drive away potential investors and thereby reduce the flow of capital to development projects. In contrast, in the bond market sharp-edged benchmarking no doubt improves the efficiency of investment management, but commoditization of assets brings relentless competition and efficiency that drives away opportunities for superior returns as investors compete with each other in the flow of capital.

It seems likely that benchmarking can be useful in examining real estate development project investment performance in spite of the data problems inherent in such an exercise. Benchmarking can potentially serve several purposes, and perfection in the benchmark indices is not necessary for some of these purposes. If benchmarking is applied carefully, keeping in mind the limitations of the data, it should facilitate the alignment of interests between investors and managers, and it may generate insights regarding the nature and causes of specific ex post performance results. Such interest-alignment and diagnostic functions are probably more important than ex post performance evaluation of investment managers, particularly for simulated property-level indices of the type described in this article.

APPENDIX

The WACC Formula, and Leverage Viewed as a Combination of Long and Short Positions: Some Implications for Risk and Return in Development Investments

The returns to a net position are *levered* with respect to the returns to the underlying components of that position whenever the underlying components are not perfectly positively correlated. That is, the returns to the net position tend to be *magnified* (in either a positive or negative direction) relative to those of the underlying components of the position. This can result in effective "operational leverage" even in the absence of the use of formal debt financing ("financial leverage"). The basic weighted average cost of capital formula (WACC) is a useful device to quantify the effect of leverage, whether it is operational or financial in nature, and this can be useful in thinking about the returns to development projects. This Appendix will review this point at a conceptual level, using basic algebra and statistics.

Let V be the value of a benefit, D be the value of a cost, and E be the net value or profit: $E = V - D$, where both V and D (and therefore also E) are random variables over time. Thus E consists of a combination of a "long" (positive) position in V plus a "short" (negative) position in D.

First we will use algebra to derive the classical WACC formula for the relationship between the returns to these three variables. Begin by expressing the $E = V - D$ relationship in percentage changes:

$$\frac{\Delta E}{E} = \frac{\Delta V}{E} - \frac{\Delta D}{E} = \frac{\Delta V}{E}\frac{V}{V} - \frac{\Delta D}{E}\frac{D}{D} = \frac{V}{E}\frac{\Delta V}{V} - \frac{D}{E}\frac{\Delta D}{D}$$

Note that $E = V - D$ implies that: $D = V - E$, and substitute into the above formula:

$$\frac{\Delta E}{E} = \frac{V}{E}\frac{\Delta V}{V} - \frac{(V-E)}{E}\frac{\Delta D}{D}$$
$$= \frac{V}{E}\frac{\Delta V}{V} - \left(\frac{V}{E} - 1\right)\frac{\Delta D}{D} = \frac{\Delta D}{D} + \frac{V}{E}\left(\frac{\Delta V}{V} - \frac{\Delta D}{D}\right)$$

Now label as follows: $\Delta V/V$ is r_P, the percentage "return" on the benefit (or the return on the underlying property); $\Delta D/D$ is r_D, the return on the cost (or debt); $\Delta E/E$ is r_e, the return on the net profit (or equity in the construction project); and V/E is LR, the leverage ratio. Then the above formula is seen to be the classical WACC formula:[32]

$$r_e = (LR)r_P + (1 - LR)r_D = r_D + \left(r_P - r_D\right)LR \quad \text{(A-1)}$$

The return to the net position equals the return on the shorted asset plus the leverage ratio times the difference between the return on the long asset minus the return on the shorted asset. Of course LR is always at least equal to unity, so it is obvious by immediate inspection of (A-1) that r_e will be greater than either r_D or r_P whenever $r_P \geq r_D$. Similarly, when $r_P < r_D$, leverage works the other way, and r_e ends up being less than either r_D or r_P. Thus, leverage magnifies the volatility of r_e as compared to that of either r_P or r_D. As noted in most basic finance texts, Formula (A-1) is exact only for instantaneous returns in which LR can be assumed to remain constant, but it is a useful approximation over the time intervals that are typically relevant for computing development project IRRs. (And the fundamental qualitative point about the magnitude of volatility remains valid even over longer intervals.)

While it is obvious from inspection of (A-1) that leverage magnifies the volatility in the net position, we can apply statistics to learn more about the relationship between the variance of the three returns over time. Recall from basic statistics that the variance of a random variable X times a constant a equals a^2 times the variance of X: $VAR[aX] = a^2 VAR[X]$. Also recall that the variance of a sum equals the sum of the variances plus twice the covariance: $VAR[X+Y] = VAR[X]+VAR[Y]+2COV[X,Y]$. Finally, the covariance between two products of a random variable and constant can be simplified as: $COV[aX,bY] = abCOV[X,Y]$. Combining these formulas we have a more general formula for the variance of a combination:

$$VAR[aX+bY] = a^2 VAR[X] + b^2 VAR[Y] + 2abCOV[X,Y]$$

Applying this to Formula (A-1), and recognizing that $(1 - LR) = -(LR - 1)$, we obtain:

$$VAR[r_e] = (LR)^2 VAR[r_P] + (LR-1)^2 VAR[r_D] - 2(LR)(LR-1)COV[r_P, r_D] \quad \text{(A-2)}$$

Formula (A-2) looks complicated, but if you recognize that:

$$COV[r_P, r_D] = (STD[r_P])(STD[r_D])(CORR[r_P, r_D])$$

then a little playing around with numerical values in (A-2) quickly reveals that, unless r_P and r_D are pretty highly positively correlated or LR is pretty low (near unity), $VAR[r_E]$ will be substantially greater than either $VAR[r_D]$ or $VAR[r_P]$.

Some special cases are particularly interesting. If r_D is constant (that is, not a random variable, as with riskless debt or fixed construction costs), then both $VAR[r_D]$ and $COV[r_P, r_D]$ are zero and (A-2) becomes:

$$VAR[r_E] = (LR)^2 VAR[r_P]$$

which implies: $STD[r_E] = (LR)STD[r_P]$, that is, the volatility of the net position simply equals the volatility of the long (underlying) asset times the leverage ratio.

If both r_D and r_P are random (as with risky debt or variable construction costs), but $CORR[r_P, r_D] = 0$, then (A-2) becomes:

$$VAR[r_E] = (LR)^2 VAR[r_P] + (LR-1)^2 VAR[r_D]$$

In this case, the volatility of the net position will be even greater, exceeding LR times the volatility of the underlying long asset, as both $(LR - 1)^2$ and $VAR[r_D]$ must be positive.

Finally, consider the case where r_D and r_P are perfectly positively correlated and always equal to one another (as if, whenever property values change by x percent, construction costs exclusive of land will also change by x percent—not a realistic situation but instructive for illustrative purposes). Then we have: $r_D = r_P$, which implies: $COV[r_P, r_D] = COV[r_P, r_P] = VAR[r_P]$, and (A-2) becomes:

$$VAR[r_E] = VAR[r_P]$$

In this case leverage has no effect on the volatility of the net position. Indeed, (A-1) reveals that in this case: $r_E = r_P$, the net position is identical to the gross (or pure long) position in the underlying asset. In other words, leverage is impossible using only a single asset.

ENDNOTES

[1]This is partly because many of the opportunity and value-added funds are currently not NCREIF members. It should also be noted that the NCREIF "database" is distinguished from the NCREIF Index. There are more properties in the NCREIF database than are included in the index, because some properties do not meet the index inclusion criteria. For example, one criterion for initial inclusion of a property in the index is that the property must be at least 60% leased. Note, however, that once a property is included in the index, it remains in the index, even if it subsequently drops below the initial criteria.

[2]Use of simulated indices is not unprecedented in real estate investment. For example, the Giliberto-Levy Commercial Mortgage Price Index (GLCMPI) is a simulated return index based on the ACLI loan portfolio and various assumptions about how the value of such a portfolio should change over time. (See www.jblevyco.com.)

[3]For further elaboration of many of the points contained in this and the next section, see Chapter 29 (especially section 29.5, pp. 786-800) in D. Geltner and N. Miller, *Commercial Real Estate Analysis & Investments*, South-Western College Publishing Co., Cincinnati, OH, 2001.

[4]If the land is not already owned by the development investor, it must be purchased at this time. If it is already owned, then the opportunity to sell the land *as such* (that is, as a developable land parcel) is foregone upon the commencement of the construction project.

[5]While the investor may continue holding the completed asset, either with or without permanent financing, the completed property enters a different phase of its life cycle with a different level of investment risk. It is therefore appropriate to place the property at that point into a different index for benchmarking purposes, in order to maintain style-purity of the benchmark indices. It may be appropriate to further distinguish between development (construction phase) investments and lease-up phase investments (after physical completion, prior to stabilized operation). A simulated benchmark index for the lease-up phase investment can be developed similar to what is described in this article for the construction phase. (A white paper describing such a benchmark is available from NCREIF.)

[6]From a fundamental economic perspective, the defining characteristic of development is the commitment of land. The development (or redevelopment) option held by the landowner (which is the source of the value of the land) is exercised. As with the exercise of any option, this is an irreversible act in which the possibility of waiting to exercise later on the same parcel of land (or, for that matter, of building on that site a different type of building than that being built in the project), is foregone. In other words, the *option value* per se is given up, and this represents the up-front opportunity cost of the development project, the major part of the up-front investment, as reflected in the value of the land. (For an explanation of the

relationship between land value, development options, and the opportunity cost of development, see Chapter 28 in Geltner and Miller, *op.cit.*)

[7]Using the construction loan's interest rate (or more precisely, its probabilistic expected return, the opportunity cost of its capital) we can grow the construction draws forward to the time of project completion, or we can discount them back to the time of project commencement. Indeed, we must do this to translate cash flow values across time, whether or not a construction loan is employed.

[8]The timing when the equity investor actually experiences the cash outflow to pay for construction affects the degree of leverage. To see this, consider two extreme cases. In both cases the up-front land cost is $20 and the property is forecasted to be worth $100 upon completion of construction a year from now. In the first case construction is to be paid for through a construction loan that will be paid off entirely and only upon completion. Thus, the up-front equity investment is $20 and this is levered to a 5-to-1 ratio ($100/$20). In the second case the construction is to be paid for by the equity investor entirely up-front at the commencement of the project (at the same time as when the land cost is incurred), through a "construction bond" in the amount of $70, whereupon the contractor is committed to produce and deliver the completed building a year later. (Of course this is hardly ever done in practice, but conceivably it could be, for example by the use of an escrow account.) In this second case the development investor has paid $90 today ($20 for land plus $70 for construction) for the future delivery of a building one year from now expected to be worth $100 then. This is a prepaid forward purchase, but without significant leverage. It is equivalent to buying an identical completed building today free and clear of debt, and then foregoing the first year's net income. There is some additional risk inherent in the forward purchasing, but is small for a one-year project (roughly equivalent to a leverage ratio of 1.11, or $100/$90).

[9]Even if we already owned the land, we incur at this point in time an *opportunity cost* equal to the current market value of the land, as noted previously. For example, instead of building on it, the land could have been sold as it was (presumably to another developer or to a land speculator). The "other up-front fees" include other cash outflows the equity investor must pay at the time of project commencement. These typically include items such as architectural and engineering fees, local government approval fees, some legal and financing origination fees, and often some sort of developer fee to cover the developer's previously incurred administrative and overhead costs directly or indirectly associated with the project. Although non-trivial, the totality of such fees is normally dwarfed by the opportunity cost of the land.

[10]Note that the greater risk described in our previous example was due purely to leverage, not to any speculative nature of the development project. Indeed, the leverage described in this example would exist even for development projects that are entirely pre-leased, or for build-to-suit projects.

[11]Although the WACC is only an approximation for multi-period return measures such as the IRR, it is generally a useful approximation for durations typical of most construction projects.

[12]To illustrate, consider again our previous apartment project example. If we define LR using the $10,000,000 anticipated completed property value and the $2,000,000 up-front equity investment, then $LR = 10/2 = 5$. Now apply Formula (1b) to the unanticipated deviation in the returns using this leverage ratio. The underlying core property value deviated by 10% from its prior expectation (implying a change of 10% in r_P), while the construction cost remained constant (implying zero deviation in r_D). Plugging these numbers in Formula (1b) we obtain the 50% deviation in the return to the up-front equity investment (around its prior expectation):

$$\Delta r_E = \Delta r_D + (\Delta r_P - \Delta r_D)LR \quad \Rightarrow$$
$$50\% = 0\% + (10\% - 0\%)5$$

[13]Actually, during the 1978-2000 history of the NPI, the average ex post total return risk premium earned by the NPI over T-bills was slightly less than 250 basis points per annum. However, 300 bps is a more typical ex ante risk premium for core real estate as expressed in investor surveys regarding going-in IRR assumptions. So 300 bps is a reasonable rate to use for $E[RP_P]$, at least for pre-leased projects. Another 100 to 300 basis points might be added to the appropriate $E[RP_P]$ value for speculative development projects, to reflect leasing risk. Regarding $E[RP_D]$, interest rate spreads in construction loans typically exceed 200 bps over T-bills, but much of that spread reflects ex ante yield degradation in the stated contractual interest rate. The stated contractual interest rate on a loan must be distinguished from the unconditional expected return on the loan. It is the latter that is represented in Formula (3). Stated yields on loans are derived from the loan's contractual cash flows ignoring the possibility of default on the loan (which causes yield degradation for the lender). Expected returns on the loans reflect the probability of default and the expected credit losses in the event of default. When default probability and conditional expected credit losses are factored in, unconditional expected returns to construction loans are probably 100-200 bps lower than their stated contractual interest rates (the difference being the effect of ex ante yield degradation). This suggests that $E[RP_D]$ should be a very small risk premium. (After all, construction loans have very little interest rate risk—their primary source of risk is default and associated credit losses.) With this in mind, 100 bps would seem to be a reasonable estimation for $E[RP_D]$.

[14]The leverage ratio to employ in Formula (3) should usually be a bit larger than the inverse of the expected equity component of the completed project value. For example, recall in our apartment project illustration the expected completed property value was $10,000,000 and the construction loan balance due at that time was $7,680,000, which would imply a land

value component of $2,320,000, or 23.2% of the gross property value. The inverse of this is 1/0.232 = 4.31. However, we saw in that illustration that the effective leverage ratio was 5. This is because the effective leverage ratio is based on the completed project value (as of the time of construction completion) divided by the up-front equity investment (as of the time of project inception). The present value of the up-front equity investment has to be less than the equity component value at completion in order to provide the equity investment with a positive return. Also, it should be noted that if no construction loan is used (i.e., an all-equity project, with construction payments made as the costs are incurred throughout the project), then the effective leverage ratio is reduced. Operational leverage alone may provide leverage ratios in the neighborhood of 2, even for an all-equity project (with a completed property value/land ratio around 5), depending on the time profile of the construction payments (the later the payments, the higher the effective leverage).

[15]This assumes that the equity investment in the project is based on the current fair market value of the land. In other words, 16% is the opportunity cost of capital relevant for the equity investment, an *equilibrium* expected return, only if all the values employed in Formula (3) are based on fair market values of all the variables in the formula. That is, $E[RP_D]$, $E[RP_p]$, as well as the V and E values used to compute LR, must all be based on fair market values and/or market (equilibrium) expectations, in order for the derived $E[r_c]$ ex ante return to also represent a fair market (equilibrium) expectation. If "supernormal" or "sub-normal" (e.g., subsidized) values are used for the debt or property parameters on the right-hand side of Equation (3), then the resulting development equity return will reflect the levered impact of such particular arrangements (i.e., not a "normal" or market return).

[16]For example, in our previous apartment project illustration, where 16% was the appropriate development project OCC, the present value of the equity investment is computed as: $2,320,000 / 1.16 = $2,000,000. If the opportunity cost of the land plus the up-front fees for the project totaled less than $2,000,000, then this development investment would have a positive NPV equal to the difference. Recall that all that is required for an investment to make sense is a non-negative NPV compared to any mutually-exclusive alternatives. In the case of real estate development projects, the primary mutually-exclusive alternative to the present development is to postpone the development (i.e., the so-called "value of waiting to invest"). This is a value that should normally be fully reflected in the opportunity cost of the land. Thus, a non-negative NPV for the project including (that is, after subtracting) the value of the land should normally be sufficient to imply optimal development of the site. (See Chapters 28 and 29 of the previously cited Geltner-Miller text for further elaboration.)

[17]Remember, however, that corporate bond yields are "stated yields" (or contractual yields), which will not be met in the event of default. In this sense they do not represent expected returns in the statistical sense of the expectation as the mean of the return probability distribution.

[18]For further elaboration of the points in this section, see Question 2.3.3 (pp. 25-26) and Chapter 7 (pp. 72-78) in D. Geltner and D. Ling, "Benchmarks & Index Needs in the U.S. Private Real Estate Investment Industry: Trying to Close the Gap. Part II: Technical Report," RERI working paper, October 2000 (free download available at www.reri.org).

[19]Outliers can be a serious problem with IRRs, because mathematical circumstances which lead to non-existent, multiple, or very "wild and weird" IRRs can occur in development projects, due to high leverage and possible multiple cash flow direction shifts over time.

[20]The latter type of index construction can only be done by NCREIF staff as it requires penetration of the database masking criteria.

[21]This is necessary in order to give the up-front equity investors a positive expected return. To be more specific, as of project inception the expected leverage ratio in the IRR is: $LR = F_{t+T} / E_t$. Since $E_t = E_{t-T} / (1+E_t[r_c])^T$ where $E_t[r_c]$ is the developers' expected return when they make their up-front equity investment, this results in:

$$LR = TLR\ (1+E_t[r_c])^T$$

For example, in our apartment project illustration, LR was 5, TLR was 10 / (10 – 7.68) = 4.31, $E[r_c]$ was 16%, and T was 1. Thus: 5 = 4.31*1.16.

[22]Bear in mind that E_t reflects the *opportunity cost* of the land as of time t, a value that reflects the profit-making potential of the development site as of that time. E_t may be larger than the *historical* cost of the land if it were purchased earlier by the developer (indeed, this would be expected to be the case, as the developer should have earned a return on his land investment while he held it for speculation). Also, it is important to distinguish return on *real estate* from return on *human capital*. To the extent that the developer has added value to the site by virtue of his entrepreneurial skill as a developer (e.g., in his compilation of the site, his design of the development, his obtaining of necessary political and administrative approvals, his obtaining of pre-lease commitments, and his putting together of the overall "package"), such added value may be viewed as a return on the developer's human capital (or payment for his entrepreneurial services). Such returns (or payments) may be earned by the developer, but not by an outside (passive) equity investor in the development project who enters only at time t. E_t represents the price such an outside investor must pay, and it may include some profit to the developer (e.g., in the form of fees or land price).

[23]The value (*EndVal* + *PS* – *BegVal*) will be substituted for (*EndVal* + *PS* – *CI* – *BegVal*) in the official NPI appreciation returns. This is because physically new and up-to-date buildings are constructed in development projects, and such structures should not exhibit the effects of depreciation or the

need for additional capital improvement expenditures just after completion.

[24]Various other ways could be devised to simulate this expected property value growth or appreciation rate. For example, a "rational expectations" approach would be to forecast the future NPI appreciation returns from the prior NPI history. However, the more simplistic approach we are suggesting here should be easier for practitioners to understand. It may also be closer to what developers actually do in practice.

[25]Thus, in our previous example with the T-bill yield at 5% and $LR = 5$ where we found $E_t[r_c] = 16\%$ for a pre-leased project, we would obtain $E_t[r_c] = 5\% + (1\% + (5\% - 1\%)*5) = 26\%$ for a speculative development project.

[26]Recall that, in principle: $LR = (1+E_t[r_c])^T\ TLR$. However, we cannot employ this relationship to estimate LR from TLR in this case, because that would introduce a circularity into the model. In Formula (8) we need to estimate LR in order to estimate $E_t[r_c]$, but we need to already know $E_t[r_c]$ in order to estimate LR from TLR. To deal with this circularity we employ an *approximation* of $E_t[r_c]$ in order to estimate LR from TLR. In particular, we employ: $E_t[r_c] \approx 0.05 + 0.03(TLR)$ in the estimation of LR for Formula (8). Thus, $LR = TLR(1.05 + 0.03(TLR))^T$.

[27]This is analogous to users of bond indices adjusting for differences in duration between the subject portfolio and the benchmark index. Note that users should employ lower TLR values for all-equity financed projects, that is, projects that pay for their construction throughout the construction phase rather than in a single lump payment upon completion. For example, if the TLR evaluated (as it should be) as F_{t+T} / E_{t+T} is in the neighborhood of 5, then the user should employ a benchmark index based on a TLR of around 2 for an all-equity project (i.e., a development project that uses no debt, assuming cash payments distributed approximately uniformly through the time of construction).

[28]The quarterly IRR is annualized as $(1+\text{IRR})^4 - 1$.

[29]Such a series could be published by NCREIF, or by another entity based on the published NCREIF aggregate indices.

[30]Note that with $TLR = 1$ [no terminal leverage: $E_t = F_{t+T} / (1 + E_t[r_t])^T$], the NPI TWRR is very similar to the corresponding development project IRR. Differences result from the fact that the development index reflects the effect of forward-purchasing of the NPI appreciation level index at prices based on prior *forecasted* values of the NPI (with the forecasts based on extrapolation of past CPI inflation). Another source of difference is that the NPI TWRR derives largely from ongoing income receipt whereas the development project IRR derives purely from appreciation (but based on expected total returns that are similar to the long-run NPI total return).

[31]It is not clear how such added volatility could be represented in the simulated benchmark index. We could model extra random noise or added deviation of NPI appreciation returns (away from their long-run mean), but neither of these approaches would necessarily reflect what happens with speculative projects.

[32]Note that Formula (A-1) is mathematically equivalent to:

$$r_P = \left(D / V\right) r_D + \left(E / V\right) r_E$$

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